

- Fig. 11. Ditto of *Acrida viridissima*, showing two sets of longitudinal muscles.
12. The marginal disks of the Crane-fly attached to the nerve-centres: *l'*, *l'*, *l''*, those of the legs; *pa*, that of the prothoracic appendage; *w*, *w'*, those of the wings and halteres.
13. Thorax of *Goerius olens*, showing the dorsal plate of the fifth segment, *i*, attached thereto and separated from the succeeding abdominal ones: *ps'*, the postscutellum of the metathorax.
14. Vertical thoracic muscles of *Æshna grandis*, showing a distinct repetition, 1 2 3 4, 1 2 3 4, in each segment.
15. The subtriangular metaphragma of *Rhizotrogus solstitialis* formed by the postscutellum of the segment, for comparison with the postscutellum in fig. 13.
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Instincts and Emotions in Fish.

By FRANCIS DAY, F.L.S.

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DURING the last few years the instincts of brutes have received much attention from biologists, while those of fishes have been generally passed over. Some naturalists have not hesitated to assert that the lives of the finny tribes are destitute of the joys and sorrows generally appertaining to vertebrate animals, attributing to them an almost vegetative existence. In a work lately published in this country, Cuvier's low estimate of their intelligence has again been adopted in its entirety, although during the course of this century much information has accumulated pointing in an opposite direction. Irrespective of this, the ancients must have had a higher opinion of the finny tribes than the authors of the present time, if we are to judge from the attributes they accorded to fish.

But returning to half a century since, we find that Cuvier had no very exalted opinion of the intellect of fishes, considering that among all the vertebrate animals they show the least signs of sensibility, which of course might be expected, as they are the lowest division. Nearly or quite destitute of any voice, with immovable eyes and a fixed osseous face, their physiognomy has no play, their emotions no expression, only capable of hearing the loudest sounds, for, condemned to reside in an empire of silence, they have but small occasion for the sense of hearing. No tear

moistens, no eyelid shelters or wipes the surface of the eye, which is but an indifferent representative of that organ as existing in the superior classes of animals. Delicate sense of taste is said to be wanting, and that of smell to be but small; while feeling on the surface of their bodies is almost obliterated, due to the interposition of scales, and, in some species, even their very lips are converted to the hardness and insensibility of bone. To pursue their prey or escape an enemy is the constant occupation of their lives, determines their place of abode, and is the principal object of the diversities of form among them. Their sexual emotions, cold as their own blood, indicate merely individual wants. With scarcely an exception, fish do not construct a nest; they neither feed nor defend their offspring. The inhabitant of the waters knows no attachments, has no language, no affections; feelings of conjugality and paternity are not acknowledged by him; ignorant of the art of constructing an asylum, in danger he seeks shelter among rocks or in the darkness of profound depths: his life is silent and monotonous.

What a gloomy picture is here sketched out respecting fishes! Eager in the pursuit of prey in order to satisfy the cravings of hunger, or terrified at the approach of danger, their lives, which are said to be silent, monotonous, and joyless, would appear to be scarcely worth preserving; death itself, one would imagine, must be a happy release from a burdensome existence. But fishermen are well aware that the finny tribes are as eager to escape from danger, or avoid capture, as are the inhabitants of the earth or the frequenters of the air, which compels us to question whether their lives are so joyless as has been represented—if anger or affection are really among their unknown passions.

I will first observe upon the means possessed by fishes enabling them to demonstrate their emotions. First, we find that they are capable of erecting their dermal appendages, as scales or fin-rays, under the influence of anger or terror, similarly as feathers or hairs are erected in birds and mammals. But special expressions, as those of joy, pain, astonishment, &c., we could hardly anticipate being so well marked in fishes as in some of the superior grades of animals, in which the play of the features frequently affords an insight into their internal motions. Eyes without movable eyelids, cheeks encased with bony plates or covered with hard scales, are scarcely suitable for smiling or developing into a laugh. Ex-

ternal ears likewise are wanting. Still we perceive one very distinct expression in this vertebrate class which is absent, or but slightly developed, in many of the higher animals, namely, *change of colour**. Most of us are aware that when a fish sickens its brilliant tints become less and less, or even entirely fade away, while the same result may follow being vanquished by a foe. But when in good health and residing in suitable localities, especially during the breeding-season, their colours become vivid, and even a temporary accession of anger may cause a similar result.

The first subject for investigation is, *Are the finny tribes destitute of affections?* Here I purpose inquiring whether fish are monogamous or polygamous, whether they show signs of affection to their companions, if they construct nests, guard their nests or eggs, protect their offspring, and, lastly, if they are ever known to exhibit traits of affection for human beings. In some parts of the world, more especially in fresh waters, we have monogamous as well as polygamous fishes—the former, as a rule, not depositing so many eggs as the latter, probably for two reasons, (1) that they breed more frequently, and (2) that they generally protect their offspring. The Gouramy (*Osphromenus olfax*) at the Mauritius commences breeding at six months of age, while their fecundity is astonishing. During the breeding-season they frequent the sides of tanks, where shelter is afforded them by the grasses and weeds growing in the water. For several days they are very active, passing in and out of their grassy cover, and in some places thickening it by entangling all trailing shoots, and forming what is generally considered the spot under which the ova are deposited†. They continue to watch this place with

* It is not here held that change of colour is always due to emotional sensations. Thus Professor Agassiz observes that in young *Pleuronectoids* the embryos were very sensitive to light, both sides changing colour rapidly at will. He considers that as soon as the two eyes become situated exclusively on one side of the head, the nerve controlling the colour-cells, of what has now become the eyeless side, becomes gradually unable to act, consequently the under or blind side becomes colourless. It seems to be an almost invariable fact that the under surface in fish is less vividly coloured than the upper surface, and that such is occasioned by the influence of light; but whether such is entirely due to the action of the optic nerve is open to grave doubt, for were it so, all blind fish would be colourless; and here, again, we must distinguish between those which are sightless owing to living in dark caves, and others which are so consequent upon accidental loss of vision in their embryonic stage.

† On nest-building fishes, see Martens, Zool. Gart. 1872, pp. 107–111.

the greatest vigilance, driving away any interloping fish; and at the end of a month numerous fry appear, over which the old Gouramies keep guard many days*. M. Carbonnier, who has studied the habits of the Chinese Butterfly-fish (*Macropodus*) in his private aquarium in Paris, where he had some in confinement, observed† that the male constructs a nest of froth of considerable size, 15 to 18 centimetres horizontal diameter, and 10 to 12 high. He prepares the bubbles in the air (which he sucks in and then expels), strengthening them with mucous matter from his mouth, and brings them into the nest‡. Sometimes the buccal secretion will fail him, whereupon he goes to the bottom in search of some confervæ, which he sucks and bites for a little in order to stimulate the act of secretion. The nest prepared, the female is induced to enter. Not less curious is the way in which the male brings the eggs from the bottom into the nest. He appears unable to carry them up in his mouth; instead of this, he first swallows an abundant supply of air, then descending, he places himself beneath the eggs, and suddenly, by a violent contraction of the muscles in the interior of his mouth and pharynx, he exhales the air which he had accumulated by the gills. This air, finely divided, partly by the lamellæ and fringes of the gills, escapes in the form of two jets of veritable gaseous powder, which envelops the eggs and raises them to the surface. In this manœuvre the *Macropodus* entirely disappeared in a kind of air-mist, and when this had dissipated he reappeared with a multitude of air-bubbles like little pearls clinging all over his body.

In Asia there are several species of Snake-headed or Walking-fishes (*Ophiocephalus*). The male of the common striped form, *O. striatus*§, constructs a nest with his tail among the vegetation at the side of tanks, biting off the ends of the weeds that grow in the water. Here the ova are deposited, the male keeping guard; but should he be killed or captured, the vacant post is filled by his partner. It is a curious sight to see them with their fry swimming along near the surface of the water, the latter generally

* General Hardwicke, Zool. Journal, iv. 1829, p. 309.

† Bulletin de la Société d'Acclimatation, Paris, 1872.

‡ The same fact has been observed of the *Gasterosteus aculeatus* by Mr. Mabel, the Curator of the Weston-super-Mare Museum.

§ *Pristolepis malabaricus*, which is not amphibious, constructs a nest according to Mr. Thomas.

going in single file above them. The parents are very fierce at this period, and defend their offspring with great courage*. I have likewise personally witnessed in Canara the young of the orange Walking-fish, *O. aurantiacus*, swimming about with their parents, by whom they are protected, according to native fishermen, until they are able to shift for themselves, when they are driven away by their progenitors. The fishes enumerated as monogamous, viz. *Osphromenus*, *Macropodus*, and *Ophiocephalus*, are all amphibious Acanthopterygians and inhabitants of Asia. I will now pass on to examples taken from other localities.

Pennant† remarks that the river Bullhead (*Cottus gobio*) deposits its spawn in a hole it forms in the gravel, and quits it with great reluctance. We are told of a Russian fish, Bitshki‡, that it is one of the most remarkable of those in the Black Sea, and always occasions fever in whoever eat it, while it builds for its young a nest like a bird. The male and female unite their cares in its construction, gathering seeds and soft seaweeds, and depositing them in small holes on the shore. In this the female not only lays her eggs, but watches them carefully like a hen; and when the little ones are hatched, they remain near the mother till they are sufficiently grown to venture forth alone into the world of waters.

In South America two species of monogamous fish, termed "Hassar" and also "Hardback," of the genus *Callichthys*, have been observed to construct nests—the flat-headed form (*C. asper*) of leaves, and the round-headed kind (*C. punctatus*) of grass; in these they deposit their eggs, which they carefully cover, and both sexes watch and defend them till the young come forth. The late Dr. Jerdon§ remarked of the beautiful little *Etroplus maculatus*, an inhabitant of the streams of Southern India and Ceylon, that the eggs, which were not very numerous, were deposited in the mud at the bottom of a stream; and when hatched, both parents guarded their young for many days, vigorously attacking any large fish that passed near them. It is evident, in this case, that they must have remained in the vicinity of their eggs and watched over them until the young came forth. The Lump-sucker, *Cyclo-*

* Col. Puckle, Report on the Fishes of Bangalor.

† Brit. Zool. iii. 1776, p. 216

‡ Koht's 'Russia.'

§ Madras Journ. Lit. and Sc. 1849, p. 143.

pterus lumpus, is, according to Yarrell and others, a fish that shows attachment for its eggs. At the spawning-time the female precedes and deposits her ova among the larger algæ and in fissures of the rocks; the male shortly follows and fructifies the eggs, adhering so closely to the mass of roe that the impression is left upon the hollow surface of the shield formed by the ventrals, after which he keeps watch over the deposited ova and guards them from every foe with the utmost courage. If driven from the spot by man he does not go far, but is continually looking back, and in a short time returns. Dr. Johnston observes that the fishermen in Berwickshire believe that the male covers the spawn and remains covering or near it until the ova are hatched, and that the young soon after birth fix themselves to the sides and on to the back of their male parent, who sails, thus loaded, to deeper and more safe retreats.

Agassiz remarks* that while examining the marine products of the Sargasso Sea, Mr. Mansfield picked up and brought to him a round mass of sargassum, about the size of the two fists, rolled up together. The whole consisted, to all appearance, of nothing but gulf-weed, the branches and leaves of which were, however, evidently knit together, and not merely balled into a roundish mass. The elastic threads which held the gulf-weed together were beaded at intervals, sometimes two or three beads being close together, or a branch of them hanging from the cluster of threads. This nest was full of eggs scattered throughout the mass and not placed together in a cavity. It was evidently the work of the *Chironectes*. This rocking fish-cradle is carried along as an undying arbour, affording at the same time protection and afterwards food for its living freight. It is suggested that they must have used their peculiar pectoral fins when constructing this elaborate nest.

The well-known Tinker or ten-spined Stickleback, *Gasterosteus pungitius*, is one of our indigenous fish which constructs a nest. On May 1st, 1864, a male† was placed in a well-established aquarium of moderate size, and in which, after three days, two ripe females were added. Their presence at once roused him into activity, and he soon began to build a nest of bits of dirt and dead fibre and of growing confervoid filaments, upon a jutting point of

* Silliman's American Journal, Feb. 1872.

† Ransom, Ann. & Mag. Nat. Hist. 1865, xvi. p. 449.

rock among some interlacing branches of *Myriophyllum spicatum*—all the time, however, frequently interrupting his labours to pay his addresses to the females. This was done in most vigorous fashion, he swimming, by a series of little jerks, near and about the female, even pushing against her with open mouth, but usually not biting. After a little coquetting she responds and follows him, swimming just above him as he leads the way to the nest. When there, the male commences to flirt—he seems unaware of its situation, will not swim to the right spot, and the female, after a few ineffectual attempts to find the proper passage into it, turns tail to swim away, but is then viciously pursued by the male. When he first courts the female, if she, not being ready, does not soon respond, he seems quickly to lose his temper, and, attacking her with great apparent fury, drives her to seek shelter in some crevice or dark corner. The coquetting of the male near the nest, which seems due to the fact that he really has not quite finished it, at length terminates by his pushing his head well into the entrance of the nest, while the female closely follows him, placing herself above him, and apparently much excited. As he withdraws she passes into the nest, and pushes quite through it, after a very brief delay, during which she deposits her ova. The male now fertilizes the eggs and drives the female away to a safe distance; then, after patting down the nest, he proceeds in search of another female. The nest is built and the ova deposited in about twenty-four hours. The male continued to watch it day and night, and during the light hours he also continually added to the nest.

The marine “15-spined Stickleback,” *Gasterosteus spinachia*, affords another instance of nest-constructing fishes. The places selected for their nests are usually harbours or some sheltered spots to where pure sea-water reaches. The fish either find growing or even collect some of the softer kinds of green or red seaweed, and join them with so much of the coralline tufts (*Janiæ*) growing on the rock as will serve the purpose of affording firmness to the structure, and constitute a pear-shaped mass five or six inches long, and about as stout as a man’s fist. A thread, which is elastic and resembles silk, is employed for the purpose of binding the materials together; under a magnifier it appears to consist of several strands connected by a gluey substance, which hardens by exposure to the water. In one instance the situation selected was the loose end of a rope, from which the separated strands hung at about a yard below the surface in five or six

fathoms of water, to which the materials must have been conveyed at least thirty feet. The nest, which was of the usual construction, was matted together in a hollow formed of the untwisted strands of the rope, and in it were deposited the ova in the usual way. It was watched over by the parent, who did not appear to quit his station; still instances have been observed when more than one watcher was present. When the guardian is compelled to retreat, owing to a receding tide, he returns again with the first suitable wave; and in three or four weeks the young emerge. So intent is this fish on the object over which he keeps guard, that at this time he may be easily captured, but he resents all interference with the nest; if the ova are exposed, he at once repairs the breach by dragging fresh materials into a position by which they are again concealed and protected*.

Not only will some fishes protect their nests in which are deposited the ova, but forms which do not construct any receptacle for their eggs have interesting modes of protecting them or removing them from localities where they may be exposed to danger. The Siluroid, or scaleless, also termed Sheat-fishes (*Siluridæ*), although almost unknown in the colder regions of the North, become numerous as the tropics are approached, some being marine forms, others restricted to the fresh waters. These fishes delight in muddy localities, and seek their food by means of feelers placed around the mouth, as well as by means of hearing, their air-bladder forming an acoustic organ. The marine and estuary genera of which the group *Ariina* is composed, all deposit large eggs from 0.5 to 0.6 of an inch in diameter; and while examining the fishes along the western coast of India, I found many of the males of this group with from fifteen to twenty of these large eggs in their mouths. Some of these eggs were in an early stage of development, others ready for hatching, while one example contained a young fry hatched, but having the yelk-bag still adherent. They filled the cavity of the mouth and pharynx of these male fishes. Whether the male carries these eggs about in his mouth until they are hatched, or merely removes them from some spot when danger is imminent, of course may be open to question; but it is a significant fact that in none of the

* Couch, Brit. Fishes, i. p. 182. M. Gerbe (Rev. et Mag. Zool. xvi. pp. 255, 273, 337, 1865) observes that fishes of the genus *Crenilabrus* build a nest of seaweed; here the ova are deposited; both sexes assist in its construction.

examples which I dissected could I find a trace of food throughout the intestines of the males who had been engaged in this interesting occupation*. The same phenomenon was observed in two examples of *Arius fissus* which came from Cayenne, and were presented to the British Museum†, and by Dr. Hensel in the Brazilian *Arius Commersonii*. A fish from Lake Tiberias, *Chromis paterfamilias*, has been described‡, the male of which carries the eggs in the buccal cavity, the young even remaining there some time after they have been hatched. It has been remarked of the Siluroid genus *Aspredo*, that they take care of their progeny, and the females possess appendages for the purpose of keeping the eggs attached to the belly of the mother§. Some fishes, as the Salmon, the Trout, and the Shad, have been known to discontinue feeding during the breeding-season||. Among Batrachians we also see that the males may carry the eggs until hatched: thus, in *Rhinderma Darwinii*, the males have an extraordinary brood-sac developed as a pouch from the throat, and extending over a great portion of the ventral surface of the animal. In this cavity a number of living tadpoles have been observed by the Spanish naturalist Jimenez de la Espada¶.

Fish, however, have other modes of showing solicitude for the welfare of their eggs, some of which I have already mentioned; but a few more instances perhaps will not be considered superfluous. In some interesting observations respecting the construction of the nest and the habits of the "Three-spined Stickleback," *Gasterosteus aculeatus***, it has been remarked that after the deposition of the eggs the nest was opened more to the action of the water, and the vibratory motion of the body of the male fish, hovering over its surface, caused a current of water to be propelled

* Day, 'Fishes of India,' p. 456.

† Lortet, Compt. Rend. 1875, lxxxi. p. 1196.

‡ Günther, Catal. v. p. 173.

§ L. c. p. 268.

|| Max Weber, Arch. f. Nat. (2) xlii. p. 169.

¶ Sprengel, Zeitschrift für wissenschaft. Zool. vol. xxiv. part 4 (1877).

** The *Gasterosteus aculeatus*, says Baker, Phil. Trans. Roy. Soc., seek out and destroy all the young fry that come in their way, which are pursued with the utmost eagerness and swallowed down without distinction provided they are not too large. He continues that one did (on 4th of May) "devour in five hours' time seventy-four young dace, which were about $\frac{1}{4}$ of an inch long, and of the thickness of a horsehair; two days after it swallowed sixty-two, and would, I am persuaded, have eaten as many every day could I have procured them for it."

across the surface of the ova, which action was repeated almost continuously. After about ten days the nest was destroyed and the materials removed; and now were seen the minute fry fluttering upwards here and there, by a movement half swimming, half leaping, and then falling rapidly again upon or between the clear pebbles of the shingle bottom. This arose from their having the remainder of the yelk still attached to their body, which, acting as a weight, caused them to sink the moment the swimming effort had ceased. Around, across, and in every direction the male fish, as the guardian, continually moved. Now his labours became more arduous and his vigilance was taxed to the utmost extreme, for the other fish (two Tench and a gold Carp), some twenty times larger than himself, so soon as they perceived the young fry in motion, continuously used their utmost endeavours to snap them up. The courage of the little Stickleback was now put to its severest test; but, nothing daunted, he drove them all off, seizing their fins and striking with all his strength at their heads and at their eyes. His care of the young brood when encumbered with the yelk was very extraordinary; and as this was gradually absorbed and they gained strength, their attempts to swim carried them to a greater distance from the parent fish; his vigilance, however, seemed everywhere, and if they rose by the action of their fins above a certain height from the shingle bottom, or flitted beyond a given distance from the nest, they were immediately seized in his mouth, brought back, and gently puffed or jetted into their place again*. The same care of the young, bringing them back to their nest up till about the sixth day after hatching, has been remarked by Dr. Ransom in the 10-spined Stickleback, *G. pungitius*.

The usual time for the Lamprey, *Petromyzon fluviatilis*, leaving the sea, which it is annually seen to do, in order to spawn, is about the beginning of spring; and after a stay of a few months it returns again to the ocean. Their preparation for spawning is very peculiar: their manner is to make holes in the gravelly bottoms of rivers; and on this occasion their sucking power is particularly noticeable, for if they meet with a stone of considerable size, they will remove it and throw it out. Their young are produced from eggs; the female remains near the place where they are excluded, and continues with them till they come forth.

* Warrington, "On the Habits of the Stickleback," Ann. & Mag. Nat. Hist 1855, xvi. p. 330.

She is often seen with her whole family playing about her, and after some time she conducts them in triumph to the ocean. (*Buffon*.)

Among the Lophobranchiate order of fish, or those in which the gills consist of small rounded tufts attached to the branchial arches, and which are represented by the Pipe- and Horse-fishes of the British seas, we find that in most of the species the males perform the function of hatching the eggs, which for that purpose are deposited up, to the time of the evolution of the young, either between the ventrals (in the genus *Solenostomus*), or in tail-pouches (in *Hippocampus*), or in pouches on the breast and belly (in *Doryrhamphus*), or in rows on the breast and belly (in *Nerophis*), and are thus carried about by the fish*. M. Risso notices the great attachment of the adult Pipe-fish to their young, and this pouch probably serves as a place of shelter to which the young ones retreat in case of danger. I have been assured by fishermen that if the young were shaken out of the pouch into the water over the side of the boat, they did not swim away, but when the parent fish was held in the water in a favourable position the young would again enter the pouch†.

M. Carbonnier has recorded how the male of the curiously grotesque Telescope-fish, a variety of *Carassius auratus*, Linn., acts as accoucheur to the female. Three males pursued one female which was heavy with spawn, and rolled her like a ball upon the ground for a distance of several metres, and continued this process without rest or relaxation for two days, until the exhausted female, who had been unable to recover her equilibrium for a moment, had at last evacuated all her ova‡.

That adult fish are capable of feeling affection one for another would seem to be well established: thus Jesse relates how he once captured a female Pike (*Esox lucius*) during the breeding-season, and that nothing could drive away the male from the spot at which he had perceived his partner slowly disappear, and whom he had followed to the edge of the water.

Mr. Arderon§ gave an account of how he tamed a Dace, which would lie close to the glass watching its master; and subsequently

* Kaup, Catal. Lopho. Fish in Brit. Mus. 1856, p. i.

† Yarrell, Brit. Fishes, 2nd ed. ii. p. 436.

‡ Compt. Rend. Nov. 4th, 1872, p. 1127.

§ Phil. Trans. Royal Society, 1747.

how he kept two Ruffs (*Acerina cernua*) in an aquarium, where they became very much attached to one another. He gave one away, when the other became so miserable that it would not eat, and this continued for nearly three weeks. Fearing his remaining fish might die, he sent for its former companion, and on the two meeting they became quite happy again. Jesse gives a similar account of two gold Carp. Mr. Oliver has recorded how a Trout was placed in a well at Dumbarton Castle, and died in 1809, after having inhabited that locality twenty-eight years. It had become so tame that it would receive its food from the hands of the soldiers. Lacépède relates how some fish, which had been kept in the basin of the Tuileries for upwards of a century, would come when they were called by their names; while in many parts of Germany, Trout, Carp, and Tench were summoned to their food by the ringing of a bell. "At a passage-place near to the city of Kandy, the fish formerly have been nourished and fed by the king's order, to keep them there for his majesty's pleasure; whither, having been used to be thus provided for, notwithstanding floods and strong streams, they will still resort, and are so tame that I have seen them eat out of men's hands"*. Ellis, in his 'Polynesian Researches,' speaks of a native chief of the island of Hawaii who had brought eels to that degree of tameness that he could call them from their retreat with the shrill sound of a whistle. Pliny also remarks that eels may be tamed so completely that they will eat out of your hand. At Erritara Carvee, in the Cochin state of Malabar, is an umbalum situated on the bank of the deep river, which is 500 yards wide, where the fish receive a supply of food every week; here hundreds of Carp (*Barbus*) flock up to obtain rice from passers-by, and are so tame that they will take food from a person's hand†. At many temples in India fishes are called to receive food by means of ringing bells or by musical sounds. Lieutenant Conolly remarks upon seeing numerous fishes coming to the ghaut at Sidhnath to be fed when called; and on expressing our admiration of the size of the fish, "Wait," said a bystander, "until you have seen 'Raghu.'" "The Brahmin called out his name in a peculiar tone of voice, but he would not hear. I threw in handful after handful of ottah (flour) with the same success, and was just leaving the ghaut, despairing and doubting, when a loud plunge startled me. I thought somebody had jumped off the bastion of the

* Knox, Ceylon, 1681, p. 56.

† Day, 'Land of Permauls,' 1863, p. 502.

ghaut into the river, but was soon undeceived by the general shout of 'Raghu,' 'Raghu,' and by the fishes large and small darting away in every direction. Raghu made two or three plunges, but was so quick in his motions that I was unable to guess at his species"* . In Burma, in the Irrawaddi river, there are fish so tame as to come up to the sides of the boat, and even allow themselves to be handled. The Fakeers of the place call them together, but they are not much disposed to come for mere calling, seeming to require more substantial proof of being wanted in the shape of food; they are found in still waters in a small bay, which is closed up still more from the influence of the stream by a round island constructed superficially on a rocky base, and on which the pagodas are built. They resemble a good deal the *Gooroo mas*, a Siluroid of Assam, but have no large teeth as it has (most probably the fish was a *Rita*). They are very greedy, of a bluish-grey colour, occasionally inclining to red (Griffith, p. 104). Carew, in Cornwall, is said to have called his Grey Mullet together by making a noise like chopping with a cleaver; and Sir Joseph Banks collected his fish by means of sounding a bell.

The manifestations of anger are well described in the accounts we possess of the Fighting Fishes of Siam. After remarking on the cock-fights of that country, Sir J. Browning† adds, there is a little bellicose fish, too, which attacks its fellow with great ferocity, bristling its fins and exhibiting the most intense excitement; one of these, seeing its reflection in a glass, will violently advance head foremost against the shadow. Dr. Cantor‡ observes, respecting this fish, *Macropodus pugnax*, that when it is in a state of quiet, with the fins at rest, the dull colours present nothing remarkable. But if two are brought within sight of each other, or if one sees its own image in a looking-glass, the little creature becomes suddenly excited, the raised fins and the whole body shine with metallic colours of dazzling beauty, while the projected gill-membranes, waving like a black frill round the throat, add something grotesque to the general appearance. In this state it makes repeated darts at its real or reflected antagonist; but both, when taken out of each other's sight, instantly

* Conolly, "Obs. on past and present Condition of Onjein," J. As. Soc. Beng. vi. p. 820.

† 'Kingdom and People of Siam,' p. 155.

‡ 'Catal. Malay. Fish.' 1850, p. 87.

become quiet. When a few examples of the three-spined Stickleback (*Gasterosteus aculeatus*) are first turned into a tub of water, they swim about in a shoal, apparently exploring their new habitation. Suddenly one will take possession of a particular corner of the tub, or, as will sometimes happen, of the bottom, and will instantly commence an attack upon his companions; and if any one of them ventures to oppose his sway, a regular and most furious battle ensues; the two combatants swim round and round each other with the greatest rapidity, biting and endeavouring to pierce each other with their spines, which on these occasions are projected. I have witnessed a battle of this sort which lasted several minutes before either would give way; and when one does submit, imagination can hardly conceive the vindictive fury of the conqueror, who, in the most persevering and unrelenting way, chases his rival from one part of the tub to another, until fairly exhausted with fatigue. I have occasionally known three or four parts of the tub taken possession of by as many other little tyrants, who guard their territories with the strictest vigilance; and the slightest invasion invariably brings on a battle. These are the habits of the male fish alone*. After a fight between two examples a strange alteration takes place almost immediately in the defeated party: his gallant bearing forsakes him, his gay colours fade away, he becomes again speckled and ugly, and hides his disgrace among his peaceable companions, who occupy together that part of the tub which their tyrants have not taken possession of; he is, moreover, for some time the constant object of his conqueror's persecution†. We here perceive how the disgrace of defeat affects the spirits of the vanquished, and this reacting on the health, causes his brilliant hues to fade away. The conqueror, on the other hand, exulting in his victory, becomes more resplendent: he does not forget his former triumph, and considers it no disgrace to occasionally lord it over his fallen foe. Under the influence of fear, the Indian Climbing-Perch (*Anabas scandens*) not only erects its spiny-rayed fins, but also its scales, even down to those situated at the base of its caudal fin.

Every one who possesses an aquarium knows how, on a spiny-rayed fish being frightened or angry, he at once elevates his fins. The *Diodon* has several means of defence. It can give a severe

* Mag. Nat. Hist. iii. p. 330.

† Couch, 'British Fishes,' i. p. 172.

bite; while by inflating its body, the papillæ with which the skin is covered become erect and pointed*. Mr. Whitmee observes:—"I have seen a *Balistes* (File-fish) swim rapidly past its antagonist and graze its side with its file-like lateral spines." "I once tried to catch a *Tetrodon nigripunctatus* which was in my aquarium, when it inflated itself and elevated the fine spines with which the body was covered, and which were previously buried in its loose and flabby skin. This of course was under the influence of fear"†. Siluroids are furnished with more than one mode of attack. In the Ohio exists a species of this family, in which the first dorsal ray is formed of a very strong and short spine, which the animal uses to kill others of a smaller size; for this purpose it gets beneath the fish it intends to attack, and then suddenly rises and wounds it repeatedly in the belly. There is another curious form in Burma (*Macrones leucophasis*) said to swim with its belly uppermost, therefore termed by the Burmese the "Topsy-turvey fish;" it probably ascends to above its prey. Lately I have been favoured with the sight of a drawing of a fish, *Bagrus*, existing in the Nile which is observed, while in an aquarium, to swim in a similar manner. Siluroids likewise erect the osseous and armed spines of their dorsal and pectoral fins. Some years since, while stationed at Madras, I obtained several live examples of these fishes, *Macrones vittatus*, termed the Fiddler-fish in Mysore. I touched one which was lying on some wet grass; it became very irate, erecting its armed spines and emitting a sound resembling the buzzing of a bee, evidently a sign of anger or terror. Having placed some small Carp in an aquarium containing one of these fish, it rushed at a small example, seized it by the middle of its back, and shook it as a dog kills a rat: at this time its barbels were stiffened out laterally like a cat's whiskers. Couch observes of the Stickleback, or Pricklebacks, that "the bite of these little furies is so severe, that I have frequently known it, when inflicted on the tail, produce mortification and consequently death. They also use their lateral spines (ventral fins) with most fatal effect, that, incredible as it may appear, I have seen one during a battle absolutely rip his opponent quite open, so that he sank to the bottom and died."

Jesse mentions a gentleman walking by the side of the river Wey who observed a large Pike in shallow water. Pulling off

* Darwin, 'Voyage of Beagle,' iii. p. 13.

† Whitmee, Proc. Zool. Soc. 1878, p. 133.

his coat and tucking up his shirt-sleeves, he entered the water and tried to intercept the fish's return to the river, endeavouring to get his hands beneath it and throw it on to the bank. The Pike finding his escape likely to be cut off, assumed the offensive, seizing one of the gentleman's arms with his teeth and severely lacerating it: it had evidently argued that it must by force put the cause of its impediment to rout. Mr. J. Faraday, at the Manchester Anglers' Association, read a paper, in December 1878, recording an instance of apparent intelligence in a Skate which he observed while officiating as Curator of the Aquarium. A morsel of food thrown into the tank fell directly in an angle formed by the glass front and the bottom. The Skate, a large example, made several vain attempts to seize the food, owing to its mouth being on the underside of its head and the food being close to the glass. He lay quite still for a while as though thinking, then suddenly raised himself into a slanting posture, the head inclined upwards and the under surface of the body towards the food, when he waved his broad expanse of fins, thus creating an upward current or wave in the water, which lifted the food from its position and carried it straight to his mouth*.

Certain fishes likewise are endowed with specific means of showing their being affected by anger or terror, as the Electric Eel (*Gymnotus electricans*), which possesses electric organs of such power as to be capable of causing death even to large animals. Humboldt and others have recorded how the Indians in South America, when they desire to capture these fish, drive horses and mules into waters which they inhabit, when, as soon as disturbed, these eels attack the intruders. They first glide under the horses' bellies and prostrate them by repeated electric shocks, which, however, by degrees become of less and less intensity, as long rest and nourishment are required to repair the galvanic force which they have expended. It has been considered that the possession of this power is for the purpose of protecting the Electric Eel against Alligators; and it is certainly employed against other fish which it requires as food; but its onslaught on intruding horses must clearly be the effect of anger or terror. The power decreases, and is perhaps eventually lost, in examples which are kept in confinement. Even in British seas, we know, exists a fish endowed with this electric property, viz.

* Nature, Dec. 19, 1878.

the Electric Ray or Torpedo, commonly known as the Cramp-fish, *Torpedo hebetans* and *T. marmorata*. The instant it is touched it numbs not only the hand and arm, but its effects are said sometimes to extend to the whole of the body. This electric shock is thus described by Kempfer:—The nerves are so affected that the person struck imagines all the bones of his body, and particularly those of the limb that received the blow, are driven out of joint. It is accompanied with a universal terror, a sickness of the stomach, a general convulsion, and a total suspension of the mind. As examples of the Surmullet and Plaice have been found inside Torpedos, while it is manifestly impossible they could have captured such by outswimming them, it has been conjectured that they must have taken their prey by means of stupefying them with electric shocks. Whether we are to consider attacks made by Sword-fishes upon passing vessels as due to anger at being disturbed, or under the impression that they are attacking their enemies the Whales, is questionable; but it is a well-ascertained fact that the planks of numerous ships, especially in the Indian seas, have been pierced by the strong rostral apparatus with which these fishes are provided either for offence or defence.

Fear is frequently shown; as small birds mob those of prey, so little fish will mob others that they dread. Some small species were kept by Mr. Whitmee in an aquarium with an *Antennarius*, and were evidently in great dread of their carnivorous neighbour, which they continually tried to torment. In attacking it they always took care to strike at its posterior part, although this was protected by a rock of coral*.

Likewise fish, when hooked or netted, sometimes empty their stomachs by an instinctive act of fear, or to facilitate escape by lightening their load†. Hooker remarks respecting Gulls, Terns, Wild Geese, and Pelicans in the Ganges valley, that these birds congregate by the sides of pools and beat the water with violence so as to scare the fish, which then become an easy prey, a fact which was, I believe, indicated by Pallas during his residence on the banks of the Caspian Sea‡. Along the muddy shores of tropical countries and up the sides of large

* Proc. Zool. Soc. 1878, p. 133.

† Owen, 'Comp. Anat.' p. 419.

‡ 'Himalayan Journal,' i. p. 80.

rivers are many forms of fish, especially belonging to the family of Gobies or Blennies, that wander over the mud or climb rocks left uncovered by the water, or on to the damp stems of trees left exposed by an ebbing tide; and here they crawl about searching for insects: but let them be alarmed, and what an instant commotion ensues; some dive down at once into the soft mud, others fly over the water to a place of safety like a piece of slate sent skimming by a school-boy. Many small fishes, as Blennies &c., when the tide ebbs, are left in small pools, where they conceal themselves under stones. The larger Blennies quit the water, and using their pectoral fins as organs of prehension and locomotion, creep into suitable holes, where, with their heads towards the sea, they await the flow of the tide, which they know will restore them again to their native element. Often does the observer in the tropics see fish jumping out of the water in terror from some unseen foe; and should a net be skilfully placed, the cause of this commotion may be taken. I have found the Garfish (*Belone*) is occasionally the form which the smaller herrings are flying from or else the Bonito. The Skipper (*Belone vulgaris*) of the British seas is observed at times to show great terror at being pursued by Porpoises, Tunies, and Bonitos. Multitudes, observes Couch, then mount to the surface and crowd on each other as they press forwards. When still more closely pursued, they singly spring to the height of several feet, leap over each other in singular confusion, and again sink beneath. The Flying-fish (*Exocætus*) is likewise a form which springs out of the water to escape its rapacious pursuers. Friar Odoric, who visited Ceylon about A.D. 1320, observe that there are "fishes in those seas that come swimming towards the said country in such abundance, that for a great distance into the sea nothing can be seen but the backs of fishes, which, casting themselves on the shore, do suffer men for the space of three daies to come and to take as many of them away as they please; and then they return again to the ocean."*

Among the coral reefs of the Andaman Islands I found the little *Heliastes lepidurus* abundant. As soon as any thing splashed into the water, they appeared to retire for safety to the branching coral, a locality where no large fish could intrude; so frightened did they become, that on an Andamanese diving from the

* Hakluyt, ii. p. 37.

side of a boat, they at once took refuge in the coral, remaining in it even after it was removed from the sea. In Burmese rivers, where weirs are not permitted to entirely span rivers (as such would impede navigation), the open side as far as the bank is studded with reeds; these, as the water passes over them, vibrate, thus occasioning an unusual sound, alarming the fish and frightening them over to the weired side of the stream. Every angler knows the natural timidity of fish; and keepers are aware how easily poachers deter Salmon from ascending fish-passes.

At the Andaman Islands fish are captured by the convicts by means of weirs fixed across the openings of creeks. After existing a week or so, it is observed that captures invariably cease; and it is believed that such is due to barnacles &c. clustering on to the wood of which they are composed. It does not seem improbable that the fish have learned to avoid a locality out of terror at those which enter but do not again return.

Many fishes when captured emit sounds which appear to be due to terror, as a Scad or Horse-Mackerel (*Caranx hippos*), a Globe-fish (*Tetrodon*), and others grunt like a Pig. A Siluroid found in the Rio Parana, and called the Armado, is remarkable for a harsh grating noise which it emits when caught by hook and line: this can be distinctly heard while it is still beneath the water*. The Cuckoo-Gurnard (*Triga pini*) and the Maigre (*Sciæna aquila*) utter sounds, not only while being removed from the water, but the latter likewise, when swimming in shoals, emits grunting or purring noises that may be heard from a depth of 20 fathoms†. Herrings (*Clupea harengus*), when the net has been drawn over them, have been observed to do the same. The freshwater Bullhead (*Cottus gobio*) emits similar sounds.

Speaking of the river on which Brunei is situated in the kingdom of Borneo proper, St. John remarks:—"I have described in a previous chapter the appearance of the river; but I have not mentioned that here I have most often heard the Singing or Humming-fish, which sticks to the bottom of the boat, and produces a sound somewhat like that of a Jew's harp struck slowly, though sometimes it increases in loudness, so as to resemble the full sound or tones of an organ. My men have pointed me out a fish about 4 inches long as the author of the music. It is marked

* Darwin, 'Nat. Journal,' vol. vii.

† Yarrell, 'Brit. Fish.' 2nd edit. i. pp. 44, 106.

with alternate stripes of black and yellow across the back”*. Pallegroix observes that in Siam the Dog’s-tongue is a fish shaped like a Sole: it attaches itself to the bottom of boats and makes a sonorous noise, which is more musical when several are stuck to the same boat and act in concert†. While on board the brig ‘Ariel,’ observes Adams, in the ‘Journal of the Samarang,’ “then lying off the mouth of the river of Borneo, I had the good fortune to hear that solemn aquatic concert of the far-famed Organ-fish or Drum-fish, a species of *Pogonias*. These singular fishes produce a loud monotonous singing sound, which rises and falls, and sometimes dies away, or assumes a very low drumming character, and the noise appeared to proceed mysteriously from the bottom of the vessel. This strange submarine chorus of fishes continued to amuse us for about a quarter of an hour, when the music, if so it may be called, suddenly ceased, probably on the dispersion of the band of performers.” Sir Emerson Tennant observed that a Siluroid fish (*Clarias*) found in the lake at Colombo is said by the fishermen to make a grunt under water when disturbed. Ælian tells us that the Shad (*Clupea*) appears to take pleasure in the sounds of musical instruments; while should it thunder during the period they are ascending rivers, they rapidly return to the sea.

Companionship or friendship (as apart from affection) is shown in fishes, while we sometimes perceive such inspired by motives of gain. Mr. H. Shaw, of Shrewsbury, informs me that a gentleman near that town made the acquaintance of a Trout, over a pound weight, then residing in a brook at Borton Cliff, and was accustomed to constantly supply it with caterpillars which he obtained from the gooseberry- and other bushes and carried in a cabbage-leaf to the stream. He flicked them off into the water with a small stick, as one day he found that having taken a caterpillar up in his fingers and thrown it to the fish, it apparently seized it, but seemed at once to eject it, and with a whisk of his tail it immediately disappeared. The same result occurred after every repetition of the experiment, although it latterly returned more quickly than at first. The amount of caterpillars it consumed was enormous. Friendship here was doubtless due to this supply of food, while taste or smell must have induced fear,

* Life in the Forests of the Far East, vol. ii. p. 276.

† Pallegroix, *l. c.* p. 93.

and caused its rapid flight. Many species are gregarious, moving about in large schools; others, again, merely in pairs.

During the breeding-season most, if not all, Teleostean fishes have more resplendent tints than at any other period of the year, and which may be for the purpose of mutual attraction. A good example is seen in the Salmon, while I have observed the same circumstance occur in the beautiful little Goby (*Periophthalmus Schlosseri*) which frequents the river Irrawaddi and its banks. Jordan and Copeland*, observing upon the John Darters (*Etheostoma blennoides*), remark upon a male in their aquarium which underwent, almost in an instant, an entire change of pattern (in the colours of his body) upon the introduction of a female fish of the same species. Even after two weeks the novelty had not worn off, though his body-colours varied much from hour to hour, but had not reverted to his original dress.

There is a curious instinct of some fishes to take up their residence inside other animals, or else to attach themselves to them in order to profit by the greater power of locomotion in their host, from whose body, however, they draw no sustenance, but merely partake of such food as comes within their reach. These latter, termed *Commensals*† by Van Beneden, may be either free or fixed to their host; and a common example of a *Commensal* is the Sucking-fish (*Echeneis*), which, having but weak fins, attaches itself to any large swimming or floating object, animate or inanimate, as ships, sharks, whales, &c., not for the purpose of feeding upon them, but to enable it to profit by their powers of locomotion, and so enable it to capture other small fishes, upon which it mostly subsists. Commerson assures us that, having applied his thumb to the adhesive organ of a living Sucking-fish, the adhesion was so strong that it became numbed, and an almost partial paralysis continued for some considerable time subsequently. During stormy weather it adheres like limpets to a rock. Another circumstance related by Commerson is, that in the Indian seas a ring is fastened round the tail of one of these fish so as to prevent its escape; to the ring is attached a long cord, and it is thus carried in a vessel of salt water; and when boatmen observe a turtle asleep on the surface of the water, they approach as close as they can, then throw the Sucking-fish into the sea: it attaches itself to the breast of the turtle, and is thus drawn into the boat. The

* American Journal, 1878, p. 338.

† Bulletin Ac. Belg. 1869, xxviii. p. 621.

Lump-sucker (*Cyclopterus*) is said to fix itself by its ventral sucker to the neck of the savage Wolf-fish (*Anarrhichas lupus*), and adheres thus immovably, tormenting it in such a manner as to cause its death*.

When investigating the fishes at the Andaman Islands in 1870, one of the aborigines brought an example of the pretty yellow-and-white banded *Amphiprion percula*; and on being told that it was good, observed that she could get numbers more. She took us to an *Actinia*, which she detached from the coral rock by inserting her hand behind the attachment of this polype; and on shaking it, two more of these little fish fell out. Subsequently this was repeated to twelve others, and all had two living fishes inside them except one, which had three. They asserted that this was their usual abode. A few days previously Captain Hamilton had observed to me that some little striped fishes lived inside a polype at North Bay. One day he dug one out, dragged it to the shore, and captured three little fish from its interior; replacing them in the sea, they appeared not to know what to do, swimming round and round as if searching for something. The living polype was now returned to the sea, and they at once swam to it, following it as it was dragged back again through the water to its original locality. As I was going over to North Bay fishing, he came with me to see if he could not find a specimen. Unfortunately, after discovering one and obtaining a fish from it (*Amphiprion bifasciatum*), he was stung by the polype, which I did not see†. Dr. Andrews‡ has observed upon the *Holothuria*, or Trepang of the seas of China, that fish live inside it; in fact he saw instances of living fish entering the Trepang. On the Coromandel coast of India at Gopaulpore I found the small perciform *Therapons* residing inside *Medusæ*, and which the fishermen asserted to be of common occurrence. Gill observes§:—“In the eastern waters of the United States, however, so far as I am aware, the Stromatoid fish *Poronotus similis* (*Stromateus similis* of some authors) seems to be the most common, if not the only associate of several Acalephs, viz. *Dactylometra quinquecirra*, *Zygodactylon grænelandica*, and *Cyarea arctica*. Under the umbrellas of these species small *Poronoti* are to be found in the late

* Shaw, Zool. iv. p. 96.

† Day, “Obs. on the Andamanese,” Proc. As. Soc. Beng. 1870, p. 176.

‡ Meeting Brit. Assoc., Aug. 17th, 1878.

§ Nature, Aug. 30th, 1877, p. 362.

summers swimming, sometimes even to the number of twenty or more, but generally much fewer."

It can scarcely be denied that some fishes are endowed with a certain amount of intelligence: thus flat fishes, *Pleuronectidæ*, conceal themselves beneath the sand, as, owing to their shape, but little is required to cover them; consequently by setting up an undulating body movement, this is easily effected. Skates and Rays similarly conceal themselves in the sand. The Sand-Launce (*Ammodytes lanceolatus* and *A. tobianus*), commonly frequenting our coasts, lies imbedded in the sand, in which it conceals itself at the depth of about a foot, with its body rolled into a spiral form*. The Stargazer (*Uranoscopus scaber*) chiefly frequents shallows, where it remains hidden in the mud with merely its head exposed. In this situation it waves the beards of its lips, and especially the long cirrus of its mouth, in various directions, thus allowing the smaller fishes and marine insects which may happen to be swimming near, and which mistake these organs for worms, to become instantly seized by their concealed enemy. I obtained in March 1868 at Madras a living example of a fish belonging to this family (*Ichthyoscopus inermis*), the Tamil name of which signified "a diver into the mud." It was placed in an aquarium which possessed a bed of mud, into which it rapidly worked itself, first depressing one side and then the other, until merely the top of its head and snout remained above the mud, while a constant current of water was kept up through its gills. While in the mud it resembled a frog; if lifted out of the aquarium, it ejected water from its mouth to some distance, making a curious noise, half croaking and half snapping†. An Indian freshwater Siluroid (*Chacalophioides*) conceals itself among the mud, from which, by its lurid appearance and a number of loose filamentous substances on its skin, it is scarcely distinguishable; and with its immense open mouth it is ready to seize any small prey that is passing along‡. The Angler, or Fishing-Frog (*Lophius piscatorius*), crouching close to the ground, by the action of its ventral and pectoral fins stirs up the sand and mud; hidden by the obscurity thus produced, it elevates its appendages (situated on the upper surface of its head), moves them in various directions by way of attraction as a bait, and the small fishes approaching either to

* Shaw, Zool. iv. p. 81.

† Day, 'Fishes of India,' p. 261.

‡ Ham. Buch. 'Fish. Ganges.'

examine or seize them, immediately become the prey of the fishes (*Yarrell*). The Weaver (*Trachinus vipera*) buries itself in the sands, leaving only its nose out, and if trod on immediately strikes with great force; and we have seen them direct their blows with as much judgment as fighting-cocks*. The Conger-Eel (*Conger vulgaris*), remarks Couch, is able to insinuate the point of its tail through a crevice and so dilate it as to obtain a passage for its body by a retrograde action; or if that cannot be accomplished, it will examine by its powers of sensation, draw itself along, and, using the tail as a fixed point, elevate its body as a lever and lift itself over any opposing obstacle of considerable height; so that neither the Eel (*Anguilla*) nor the Conger can be confined within a limited space when their inclinations prompt them to wander from it.

The Jaculator-fish (*Chelmon rostratus*) frequents shores and sides of rivers near the sea in Asia in search of food. When it sees a fly sitting on the plants that grow in shallow water, it swims to the distance of 4, 5, or 6 feet, and then, with surprising dexterity, it ejects out of its long and tubular mouth a single drop of water, which never fails striking the fly into the sea, when it becomes its prey. This aroused Governor Hommel's curiosity, and he had a large tub filled with sea-water, in which he placed some of these fish. When they were reconciled to their situation, a slender stick with a fly pinned on its end was placed in such a direction on the side of the vessel that the fish could strike it. It was with inexpressible delight that he daily saw these fish exercising their skill in shooting at a fly; and they never missed their mark. Pallas continued this account from Governor Hommel's letters two years subsequently, remarking that when the Jaculator-fish intends to catch a fly or any other insect which is seen at a distance, it approaches very slowly and cautiously, and comes as much as possible perpendicularly under the object; then the body being put in an oblique situation, and the mouth and eyes being near the surface of the water, the Jaculator stays a moment quite immovable, having its eyes fixed directly on the insect, and then begins to shoot without ever showing its mouth above the surface of the water, out of which the single drop shot at the object seems to rise. With the closest attention, Governor Hommel never could see any part of the mouth out of the water, though

* Pennant's 'Brit. Zool.' iii. p. 170.

he has very often seen the Jaculator-fish shoot a great many drops one after another without leaving its place and fixed situation*.

The Common Eel, it is affirmed, voluntarily leaves the water at certain periods and wanders about meadows and moist grounds in quest of particular food, as snails &c.; it is also said to be fond of new-sown peas, which it has been observed to root out of the ground and devour during the night. If we may credit Albertus Magnus, it has been known during very severe frosts to take refuge in adjoining hay-ricks†.

Captain Arn, in a voyage to Hemel in the Baltic, gives the following interesting narrative:—"One morning during a calm, when near the Hebrides, all hands were called up at 2 A.M. to witness a battle between several of the fish called Threshers or Fox-Sharks (*Alopecias vulpes*) and some Sword-fish on one side, and an enormous Whale on the other. It was in the middle of the summer; and the weather being clear and the fish close to the vessel, we had a fine opportunity of witnessing the contest. As soon as the Whale's back appeared above the water, the Threshers springing several yards into the air, descended with great violence upon the object of their rancour, and inflicted upon him the most severe slaps with their long tails, the sounds of which resembled the reports of muskets fired at a distance. The Sword-fish in their turn attacked the distressed Whale, stabbing from below: and thus beset on all sides and wounded, when the poor creature appeared, the water around him was dyed with blood. In this manner they continued tormenting and wounding him for many hours, until we lost sight of him; and I have no doubt they in the end completed his destruction."

The master of a fishing-boat‡ has recently observed that the Thresher-Shark serves out the Whales, the sea sometimes being all blood. One Whale, attacked by these fish, once took refuge under his vessel, where it lay an hour and a half without moving a fin. He also remarked having seen the Threshers jump out of the water as high as the mast-head and down upon the Whale, while the Sword-fish was wounding him from beneath, the two sorts of fish evidently acting in concert.

The Thresher or Fox-tailed Shark attacks its enemies or defends

* "On the Jaculator-Fish by Schlosser," Phil. Trans. Roy. Soc. Lond. 1764, vol. liv.

† Shaw, Zool. iv. p. 17.

‡ 'Land and Water,' 1879.

itself by blows from its elongated tail; and Couch remarks that it is not uncommon for one to approach a herd of Dolphins (*Dolphinus*) that may be sporting in unsuspecting security, and by one splash of its tail on the water put them all to flight like so many hares before a hound.

The Pilot-fish (*Naucrates ductor*) appears to be a very companionable disposition, even though we omit the older legends that recorded how they pointed out the course of doubtful navigators, accompanying their ships throughout their voyages, and leaving them only when they had arrived at their desired haven. It is well known that they attach themselves to certain vessels for weeks and even months together, perhaps to obtain the food daily thrown overboard: but why they should accompany Sharks is a doubtful question. Some assert that this large and predacious fish is conducted to its prey by these fishes; others that they eat what the Shark leaves: however this may be, that they are often in company is an evident fact. Captain Richards, R.N., during his last station in the Mediterranean, saw on a fine day a Blue Shark, which followed the ship, attracted perhaps by a corpse which had been committed to the waves. After some time a shark-hook baited with pork was flung out. The Shark, attended by four Pilot-fish, repeatedly approached the bait; and every time that he did so, one of the Pilot-fishes preceding him was distinctly seen from the taffrail of the ship to run his nose against the side of the Shark's head to turn it away. After some further delay, the fish swam off in the wake of the vessel, his dorsal fin being long distinctly visible above the water. When he had gone, however, a considerable distance, he suddenly turned round, darted after the vessel, and before the Pilot-fish could overtake him and interfere, snapped at the bait, and was taken. In hoisting him up, one of the Pilots was observed to cling to his side until he was fairly above water, when it fell off. All the Pilot-fishes then swam about awhile, as if in search of their friend, with every apparent mark of anxiety and distress, and afterwards darted suddenly down into the depths of the sea*. Col. Smith states that he witnessed a precisely similar circumstance. M. Geoffrey, on the other hand, mentions how a Pilot-fish took great pains to bring a Shark to a bait.

Two Pilot-fishes accompanied a ship in 1831 from Alexandria to Plymouth. After she came to an anchor in Catwater, their

* Griffith, Cuv. An. King. x. p. 636.

attachment appeared to have increased; they kept constant guard at the vessel, and made themselves so familiar, that one of them was actually captured by a gentleman in a boat alongside, but by a strong effort it escaped from his grasp and regained the water. After this the two fish separated; but they were both taken the same evening, and, when dressed next day, were found to be excellent eating*.

Contempt does not seem to be unknown in this class of animals, and which appears to be sometimes shown by a stroke of the tail. Anglers frequently observe a fish swim up to their bait, not only refuse it, but give it a lash with their tail, and decline to have any thing more to do with it. This may, however, be a symptom of curiosity, which is largely developed in the finny tribes.

The poet Cowper crossing a brook, "saw from the foot-bridge something at the bottom of the water which had the appearance of a flower." "Observing it attentively," he continues, "I found that it consisted of a circular assemblage of Minnows: their heads all met in a centre, and their tails diverging at equal distances, and being elevated above their heads, gave them the appearance of a flower half-blown. One was longer than the rest; and often as a straggler came in sight, he quitted his place to pursue him; and having driven him away, he returned to it again, no other Minnow offering to take it in his absence. This I saw him do several times. The object that attracted them all was a dead Minnow which they seemed to be devouring"†.

I would submit that the foregoing facts respecting fish, collected from the writings of naturalists made in various parts of the globe, or else the result of personal observation, must lead us to doubt the very low estimate of the instincts and emotional sensations of the piscine tribes which has been attributed to them by some authors. At the same time we can hardly anticipate that these, the lowest forms of vertebrate life, have their faculties so acutely developed as they are in the higher races. Still it appears we are justified in claiming for some at least of this class of animals that they have attachments, whether in the form of conjugal feelings, paternal and maternal affections, or even of platonic friendship. Some construct nests, which they defend, as well as the young when hatched out. The males may act the part

* Yarrell, 'Brit. Fish.' 2nd. edit. vol. i. p. 172.

† Mag. Nat. Hist. v. p. 290.

of nurses to the eggs, either carrying them about in purses on even in their mouths. Lastly, I would allude to the fact that members of two distinct families may combine together for the purpose of attacking another inhabitant of the deep, and thus obtain a supply of food.

On the Extinct Land-Tortoises of Mauritius and Rodriguez. By ALFRED C. HADDON, B.A., Scholar of Christ's College, and Curator in the Museum of Zoology and Comparative Anatomy of the University of Cambridge. (Communicated by Prof. A. NEWTON, F.R.S.)

[Abstract, read November 20, 1879.]

THROUGH the generosity of Mr. Edward Newton, C.M.G., F.L.S., Lieutenant-Governor of Jamaica (late of Mauritius), a fresh collection of the remains of the Mascarene extinct gigantic land-tortoises has been added to his former gift to the Zoological Museum of the University of Cambridge.

An examination of these bones corroborates the two Mauritian species, *Testudo triserrata* and *T. inepta*, described by Dr. Günther*, but adds no fresh example to that apparently unsatisfactory species, *T. leptocnemis*. Although possessing a large series of remains from the island of Rodriguez, I am unable, like Dr. Günther, to distinguish more than the one species, *T. vosmæri*.

As examples of the inherent tendency to variation in these animals, I may draw attention to the ankylosis of the coracoid with the rest of the shoulder-girdle in one example of *T. inepta*, a circumstance which is unique; also to the variations in the coracoid of *T. triserrata* as to form, markings, &c. The *free* coracoid of *T. inepta* is also described for the first time.

From the large number of specimens examined, it is now found that the coracoid of *T. vosmæri* was very irregular as to the time of its ankylosis with the rest of the shoulder-girdle, and that it was not the "apparently individual aberration" which Dr. Günther supposed.

Measurements are given of all the most interesting bones, in a manner similar to that adopted by Dr. Günther in his monograph, to facilitate comparison.

* 'The Gigantic Land-Tortoises (living and extinct) in the Collection of the British Museum.' By Albert C. L. G. Günther, M.A., M.D., Ph.D., F.R.S. London, 1877.



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